heading the nature of the boundary is determined, and is shown to be either plane or spherical. And by the application of Green's theorem it also becomes clear that inasmuch as the statical conditions of the crystallising agent are now understood, the force functions derived in the preceding chapter can be independently deduced without aid of the assumption from any one of the primitive forms of the systems under consideration.

IV. "On some Applications of Dynamical Principles to Physical Phenomena." By J. J. THOMSON, M.A., F.R.S., Fellow of Trinity College, and Cavendish Professor of Physics in the University of Cambridge. Received December 16, 1884.

(Abstract.)

In this paper an attempt is made to apply dynamical principles to study some of the phenomena in electricity, magnetism, heat, and elasticity. The matter (including, if necessary, the ether) which takes part in any phenomenon is looked upon as forming a material system, and the motion of this system is investigated by means of general dynamical methods, Lagrange's equations being the method most frequently used. To apply this method, it is necessary to have coordinates which can fix the configuration of the system, so in the first part of the paper coordinates are introduced which fix the configuration of the system, so far as the phenomena we are considering are concerned, *i.e.*, we introduce coordinates which can fix the geometrical, the electrical, the magnetic, the heat, and the strain configuration of the system; we call these, coordinates of the x, y, z, u, and w types respectively. Some of these coordinates only enter the expression for the kinetic energy through their differential coefficients, and may be called gyroscopic coordinates, as such coordinates are of frequent occurrence in problems about gyroscopes.

The terms which involve the x, y, z, u, and w coordinates in the expression for the kinetic energy will be of fifteen different types.

There will be those terms which are quadratic functions of the differential coefficients of the x coordinates, and corresponding terms for the y, z, u, and w coordinates; so that there are in this set terms of five different types, all of which may exist in actual dynamical systems. There are ten types of terms involving the products of differential coefficients of two coordinates of different kinds. These types are considered in order, and it is shown that we have experimental evidence for the existence of only two of them, viz.,

those which involve the product of the differential coefficients of coordinates of the x and w and of the y and z types. Thus we may write those terms which depend on the coordinates x, y, z, u, w, in the expression for the kinetic energy of any real dynamical system, in the form

$$\begin{aligned} &\tfrac{1}{2}\{xx\}\dot{x}^2+ \ldots . \\ &+\tfrac{1}{2}\{yy\}\dot{y}^2+ \ldots . \\ &+\tfrac{1}{2}\{zz\}\dot{z}^2+ \ldots . \\ &+\tfrac{1}{2}\{uu\}\dot{u}^2+ \ldots . \\ &+\ \{xw\}\dot{x}\dot{w}+ \ldots . \\ &+\ \{yz\}\dot{y}\dot{z}+ \ldots . \end{aligned}$$

when the term $\{xx\}\dot{x}^2+\ldots$ indicates a quadratic function of the differential coefficients of the coordinates of the x type.

Each of these terms is separately considered, and the physical phenomena to which it corresponds are deduced. The method used may be illustrated by considering a term of the form

$$\{\lambda\mu\}\dot{\lambda}\dot{\mu},$$

when λ and μ may be any of the five types of coordinates which we are considering.

Then, if T be the kinetic energy, we have by Lagrange's equations

$$\frac{d}{dt}\frac{dT}{d\dot{\lambda}}-\frac{dT}{d\lambda}=\text{external force of the type }\lambda.$$

If, instead of T, we consider the term $\{\lambda\mu\}\dot{\lambda}\dot{u}$, we see by this equation, and the corresponding equation for the coordinate μ, that if this term exist there will be a force tending to increase λ equal to

$$-\left\{\frac{d}{dt}((\lambda\mu)\dot{\mu})-\frac{d}{d\lambda}(\lambda\mu)\dot{\lambda}\dot{\mu}\right\}$$

and one tending to increase μ, equal to

$$-\left\{\frac{d}{dt}((\lambda u)\dot{\lambda})-\frac{d}{d\mu}(\lambda\mu)\dot{\lambda}\dot{\mu}\right\}$$

and if $(\lambda\mu)$ be a function of any other coordinate v there will be a force tending to increase v equal to

$$\frac{d}{dv}(\lambda\mu)\dot{\lambda}\dot{\mu}.$$

Thus, to take an example, Wiedemann has discovered that a longitudinally magnetised iron wire becomes twisted when an electric current flows through it. If we call $\dot{y}$ the current through the wire, $z\dot{w}$ the intensity of magnetisation, and a the twist round the axis

of the wire, then Wiedemann's discovery shown that there must be a term in the kinetic energy equal to

$$f(a)\lambda z\dot{w}.$$

where $f(a)$ denotes some function of a

Thus there will be a force of the type y, *i.e.*, an electromotive force, along the wire equal to

$$-\frac{d}{dt}\{f(a)z\dot{w}\},$$

so that, if we twist a magnetised iron wire, an electric current will flow along the wire, which will last as long as the wire is being twisted: this is known to be the case. Again, there will be a force of the type z—*i.e.*, a magnetising force along the wire equal to

$$f(a)\dot{y},$$

so that when a current flows along a twisted wire it magnetises it; this effect has also been observed. Thus, from the original experiment, we have been able, by the use of Lagrange's equation, to deduce two other phenomena. It is shown in the paper that the method indicates a great many relations between various physical phenomena. Some of these have been observed, but there are several which seem not to have been investigated; as an example of the latter, it is proved that from the effect observed by Villari and Sir William Thomson, namely, that when the intensity of magnetisation is below a certain value, an increase in the strain of a magnetised soft iron is accompanied by an increase in the magnetisation, it follows that when the magnetising force is small, a soft iron bar will contract instead of expanding on magnetisation.

Lagrange's equations were applied with great success by Maxwell to obtain the equations of the electromagnetic field.

It is also shown that the effects due to the potential energy of a system A can be produced by the kinetic energy of a system B connected with A, if the configuration of B is such that it can be fixed by gyroscopic coordinates. And thus we may look on the potential energy of any system (A) as being the kinetic energy of a gyroscopic system (B) connected with A, and so regard all energy as kinetic. If we do this it will simplify some of the dynamical principles very much. We may take the principle of Varying Action as an example: if all the energy is kinetic, its magnitude will remain constant by the Conservation of Energy, and then the principle of Least Action takes the very simple form that, with a given quantity of energy, any material system will, by its unguided motion, pass from one configuration to another in the least possible time, where, in the

phrase "material system," we include the gyroscopic systems whose motions produce the same effect as the potential energy of the original system, and two configurations are not supposed to coincide unless the configurations of these systems coincide also.

V. "On a New Constituent of the Blood and its Physiological Import." By L. C. WOOLDRIDGE, D.Sc., M.B., Demonstrator of Physiology in Guy's Hospital. Communicated by Professor M. FOSTER, Sec. R.S. Received December 16, 1884.

In a paper on the Origin of the Fibrin Ferment, published in "Proc. Roy. Soc.," vol. 36, I showed that there exists, dissolved in the plasma, a body which can give rise to fibrin ferment.

I have proceeded with my investigations, and have succeeded in making some additions to our knowledge of this subject, which I here describe. As my researches are not complete, I confine myself to as brief an account as possible.

The subject is best studied in the blood of peptonised dogs. But as I showed in the above quoted paper, similar results are obtained from normal salt plasma, so that the results are not peculiar to pepton blood. The body, the presence of which gives rise to fibrin ferment, can be isolated from pepton plasma in the following very simple manner:—The plasma having been completely freed from all corpuscular elements by means of the centrifuge, is cooled down to about 0°. The plasma, which was previously perfectly clear, becomes rapidly turbid, and after standing for some time in the cool, a very decided flocculent precipitate forms. I have already described this observation in a short note, "Ueber einen neuen Stoff des Blut-Plasmas," in du Bois Reymond's "Archiv für Physiologie," but it is necessary for me to allude to it here.

Now it is this body which gives rise to the fibrin ferment. So long as the former is present in considerable quantity the latter clots readily on passing through it a stream of carbonic acid, or on dilution, and at the same time a very considerable quantity of fibrin ferment makes its appearance.

By prolonged cooling the greater part of this substance can be removed, and with its gradual removal the plasma clots less and less readily with CO_2, and less and less ferment is formed, till finally it becomes practically incoagulable, *i.e.*, forms only a faint trace of fibrin after several days. If some of the substance be again added to the plasma, it regains its power of clotting with CO_2.

(The substance must be added before it has stood very long: see under.)